Metal ceramic crowns. Clinical and Laboratory steps

This crown can also be used to restore teeth with multiple defective axial surfaces. It will provide a very good retention, a little-bit less than a full veneer crown for the same tooth, but it has a good cosmetic result and can be done almost in every situation.

Construction of the metal ceramic crown. Clinical and Laboratory steps
1. Anesthesia
2. Tooth preparation
3. Gingival retraction
4. Impression taking
5. Temporary restoration fabrication
6. Gypsum cast fabrication
7. Wax pattern fabrication
8. Casting metal framework
9. Correction of ready metal framework on the cast model
10. Try in oral cavity and shade selection
11. Ceramic material is veneered (sintered) onto a metal frame in several firing processes
12. Correction of ready crown on the cast model
13. Try in oral cavity
14. Glazing
15. Try in oral cavity and cementation

The amount of tooth reduction necessary for the metal-ceramic crown depends on the metal and ceramic thickness. The necessary thickness of the metal is 0.4-0.5 mm for gold alloy and for simple alloy-0.2-0.3 mm.

The minimal ceramic thickness is 1.0-1.5 mm. The ceramic layer has to be at least 0.7-1.0 mm in the gingival part. Therefore, the tooth reduction is approximately 1.5-2.0 mm.

Shade selection

Use the shade guide that matches the porcelain your technician is using. Every porcelain is different, and best results are obtained if you use the same guide the manufacturer used in designating the colors of the product.

The shade should always be matched prior to preparation of the tooth to be restored. Ask the patient to remove all distractions before attempting to match a shade. Lipstick in particular should be removed. Large, bright items, such as earrings or glasses, can also distract the eye from the intended focus of attention on the teeth. Heavy facial makeup, such as rouge, could also interfere with an accurate match and would need to be removed or masked. Be sure that the teeth are clean and unstained before attempting to match a shade. Perform a quick rubber cup and paste prophylaxis in the area of the mouth where the shade is to be matched. Rinse the area thoroughly to remove any traces of the prophyl paste.
Seat the patient in an upright position with the mouth at the operator’s eye level. Position yourself between the patient and the light source.

**Ceramic material is veneered (sintered) onto a metal frame in several firing processes**

Any remaining investment or abrasive particles embedded in the surface of the casting could oxidize and release gases during firing. Oils from the skin left during handing of the casting are another serious form of contamination. « Live steam » is effective in removing residual contamination caused by surface deposits of abrasive particles.

The coping is ready for the oxidation cycle. Metal surface treatments are unique for each porcelain – alloy combination, and manufacturer’s recommendation should be followed. Bond strength varies with the surface treatment. Typically, a coping is placed in a furnace at a relatively low temperature and the temperature is raised 300 to 400 °C at a designated rate of climb. The atmosphere (air or vacuum) during this heating process, as well as the length of time at temperature, is dictated by the alloy.

Heat treatment of noble metal alloys causes the trace quantities of tin, gallium, indium, and zinc in the alloy to form oxides that enhance bonding with the porcelain. Base metal alloys, on the other hand, readily oxidize, so oxide formation must be carefully controlled. Following oxidation, most alloys require air abrasion with 50 µm aluminium oxide to reduce the layer of oxide, as excess oxide weakens the porcelain-to-metal bond.

Oxidation is only one of the functions of the initial firing. During casting, hydrogen gas is incorporated into the molten alloy. This gas, if left in the coping, can weaken the bond between porcelain and metal, causing the formation of bubbles in the porcelain. The hydrogen is released during the oxidation cycle, degassing the alloy as well as forming the important oxide layer.

The casting is now ready for the actual placement of porcelain. Opaque porcelain is applied first to mask the metal, to give the restoration its basic shade, and to initiate the porcelain - metal bond. The prepared coping is painted with a thin coating of distilled water or the specially formulated liquid, forming a thin wash which is applied with a brush. No attempt should be made to toughly mask the metal with this initial application. It is intended to completely wet the metal and penetrate the striations created by finishing. The coping is dried and fired under vacuum to a specific temperature. The vacuum is broken and the coping held at the temperature under air for 1 minute. The second application of opaque porcelain should mask the metal. The powder and liquid are mixed to a creamy consistency and applied to the coping with a brush a vibrating motion. The opaque layer should be applied as thinly as possible to still mask the metal. The coping is gently vibrated to condense the porcelain, and excess water is removed with a dry tissue. The second layer of opaque is fired using the same firing cycle. The opaque layer of porcelain should be approximately 0.3mm thick.

Between the metal and porcelain exists mechano-chemical bonding.

After opaque dentin and enamel porcelain application, this is fired as per the manufacturer’s instructions.

**Correction of ready crown on the cast model.**

**Try in oral cavity.**
During the try-in of a porcelain restoration, the following factors should be examined.

*Checking for proximal contact and marginal fit in ceramic restoration.*

They are examined as explained in cast metal restorations.

*Checking for occlusal discrepancies in ceramic restoration.*

*Evaluation of aesthetics in ceramic restorations.*

The contour of the gingival embrasure space and the placement of the incisal edge are important factors to be considered during anterior try-in.

Some mild discrepancies can be incorporated into the restoration to produce a natural appearance (enamel cracks, stained crack lines, exposed occlusal dentin, fracture lines areas of discoloration).

After trying *glaze porcelain is added and fired as usual.*

**Try in oral cavity and cementation.**

**Metal-acrylic crowns.**

1. Anesthesia
2. Tooth preparation
3. Gingival retraction
4. Impression taking
5. Temporary restoration fabrication
6. Gypsum cast fabrication
7. Wax pattern fabrication
8. Casting metal framework
9. Correction of ready metal framework on the cast model
10. Try in oral cavity and shade selection
11. Acrylic veneering
12. Correction of ready crown on the cast model
13. Try in oral cavity
14. Finishing and polishing
15. Try in oral cavity and cementation

The procedure is similar to ceramic veneering except for a few differences. One of the major differences is that only mechanical bonding exists between the metal and resin. Hence, the bond strength is considerably less.

The steps to be followed for resin veneering are:

- Mechanical undercuts (for retention) should be made over the entire metal surface to be veneered. Mechanical undercuts can be created by sprinkling plastic retentive pearls over the wax pattern before casting.
• The surface if the cast metal can be roughened using Al₂O₃ air abrasive unit.
• A small quantity opaque resin is added onto the metal surface. Body shade resin is added over the opaque resin and contoured using a modeling instrument.
• The resin should be polymerized under pressure in a warm water bath. Light cure resins are also available.
• The resin core should be carved to remove excess material. Space should be provided to accommodate incisal resin.
• Finally incisal shade resin is added and contoured using a modeling instrument.
• After polymerization of the incisal resin, the restoration is finished and polished.
Full-metal crowns. Clinical-laboratory procedures

There are numerous situations, when full veneer crowns have to be used. A number of studies have shown that full veneer crowns exhibit much more retention and resistance. The selection of a full veneer crown becomes mandatory when the tooth is small or when the occlusal forces are strong, for example if the tooth serves as an abutment for a long-span fixed or removable partial denture. The full veneer crowns also have to be used, if the partial veneer ones have been considered to a lack of esthetics or of proper restoration the tooth.

Nowadays, beside the full metal crowns, metal-ceramic and all-ceramic crowns are very often used. All the way, the full veneer crowns are overused now and it would be better to choose less destructive techniques whenever possible.

Construction of the full metal crown. Clinical and Laboratory steps
1. Anesthesia
2. Tooth preparation
3. Gingival retraction
4. Impression taking
5. Temporary crown making
6. Gypsum cast fabrication (Dies and working casts)
7. Wax pattern fabrication
8. Casting
9. Correction of ready crown on the cast model
10. Try in oral cavity and cementation

For gold alloy restorations, we need about 1.5 mm of clearance on the functional cusps and about 1.0 mm on the nonfunctional ones. For nongold alloy crowns, we need correspondingly 1.0 mm and 0.6 mm.

Gypsum cast fabrication

A die is a positive replica of the individual prepared tooth on which the margins of the wax patterns are finished. These are individual tooth replicas prepared for easier handling during wax pattern fabrication and finishing of inaccessible areas of the cast.

Ideal requirements of a die system

- The die should be easy to remove and replace in its original position.
- The die must be stable when placed in the cast.

Working cast with a removable die system

In this system a special type of working cast is prepared and the dies are carefully sectioned so that the individual dies can be removed and replaced in their original position in the cast.

Wax pattern fabrication
Apply to die compensation varnish for:

- Compensation the alloys shrinkage during metal framework casting
- Provision space for cement.

To prevent the wax from sticking to the die stone, coat the die thoroughly with die lubricant and allow it to soak in for several minutes.

**Casting**

The various steps in a casting procedure are:

- Spruing the wax pattern
- Attaching the sprue to the crucible former
- Investing the pattern in a casting ring
- Burnout of the wax pattern
- Casting
- Recovery
- Finishing and polishing

**Correction of ready crown on the cast model by the technician.**

**Try in oral cavity and cementation.**

During try in the following features are checked in the cast restoration

- Proximal contact
- Marginal integrity
- Stability
- Occlusion

Checking for proximal contacts

- The proximal contact between the crown and natural tooth should allow the passage of floss.
- Ideally the contacts should be stable and easy to maintain.

Checking for marginal integrity

- Margin adaptation with a gap around 30 μm is clinically acceptable.
- Testing whether the casting binds to the tooth surface, is helpful to determine the marginal integrity. This can be done using the following material: pressure indicating paste, powdered sprays, elastomeric detection paste.
- Marginal integrity can be assessed by moving a sharp explorer from the restoration to the tooth and from the tooth the restoration.

Checking for stability

- The restoration should not rock or rotate when a force is applied
• Instability produced by a small positive nodule on the fitting surface can be corrected by trimming.

Checking for occlusion

Occlusal discrepancies are one of the most common errors that occur during the fabrication of a fixed partial denture. Occlusal adjustment during eccentric movements (clinical correction) is necessary.

Cementation is the process by which the restoration is cemented to the tooth using a suitable luting agent.

• Preparing the casting: the casting should be cleaned by sandblasting with 50μm alumina or by steam, followed by ultrasonic or organic cleaning.
• Next the operatory side is isolated with cotton rolls.
• The cement should be mixed to a luting consistency.
• A thin coat of cement should be applied on the internal surface of the casting.
• The tooth surface is dried and the prosthesis is inserted with a firm, rocking dynamic seating force. A static load will lead to fracture.
• Next the margins of the retainers are examined to verify the fit of the prosthesis.
• Excess cement should be removed with an explorer. Floss can be used to remove the excess cement in the inter-proximal surface.
• Occlusion should be checked with articulating paper.
• The patient should be advised to avoid loading for the first 24 hours.
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Fundamentals of Fixed Prosthodontics

Preface

Fixed prosthodontics is the art and science of restoring damaged teeth and replacing missing ones with fixed prosthesis. To have a success in this field, the proper diagnosis, patient education and operative skills are of actual importance. Although a big quantity of improved materials, instruments and techniques are now present, it is enough easy to have serious complications as a result of professional mistakes. We hope this handout will help you to avoid such mistakes not only during education, but also will be a refresher for a practitioner.
Part I

An Introduction to Fixed Prosthodontics

Terminology

A crown is a cemented extracoronal restoration that covers, or veneers, the outer surface of the clinical crown. It should reproduce the morphology and contours of the damaged coronal portions of a tooth while performing its function. If it covers all of the clinical crown, the restoration is a full or complete veneer crown (Fig. 1-1). If only portions of the clinical crown are veneered, the restoration is called a partial veneer crown (Fig. 1-2).

The fixed partial denture or the bridge is a prosthetic appliance, permanently attached to remaining teeth, which replaces one or more missing teeth (Fig. 1-3).
A tooth serving as an attachment for a fixed partial denture is called an abutment. The artificial tooth suspended from the abutment teeth is a pontic. The pontic is connected to the fixed partial dental retainers, which are extracoronal restorations that are cemented to the prepared abutment teeth.

**Diagnosis**

A correct treatment plan is very important to achieve good treatment results. This can be done only after good diagnostics, which includes not only the patient’s dental condition, but also the overall physical health and physiological needs.

For a diagnostic workup the dental history, TMJ and occlusal evaluation, intraoral examination, diagnostic cast and full mouth radiographs are generally necessary.

**Treatment Planning for Single-Tooth Restorations.**

A lot of different types of restorations, such as fillings, inlays, onlays, full or partial veneer crowns are now present. The successful use of these restorations is based on thoughtful treatment planning, which is manifested by choosing a restorative material and a restoration design that are suited to the needs of the patient. The selection of the material and design of the restoration is based on several factors:

1. Destruction of tooth structure
2. Esthetics
3. Financial considerations
4. Retention

1. The severity of tooth structure destruction often dictates whether to make an inlay, onlay, a partial veneer crown or a full veneer one.
2. Nowadays the esthetic requirements of the patients became more and more decisive in the treatment planning. It is inevitably important to place “invisible” restorations especially in the front areas of the dentitions.
3. To achieve all of this, one must pay for the treatment. The dentist, on one hand, should not preempt the choice by selecting a less than optimum restoration just because he thinks that the patient cannot afford the preferred treatment. On the other hand, he or she should be sensitive enough to the individual’s situation to offer a sound alternative to the preferred treatment plan and not apply pressure.
4. Full veneer crowns, of course, are the most retentive. All the way, not always we need the most retentive type of the restoration, especially if it concerns the single-tooth restorations. It does become a special concern for short teeth, fixed and removable partial denture abutments.

Despite the treatment plan that you have chosen for any patient even a small restoration requires the institution and maintenance of a good plaque-control. If extensive plaque, decalcification and caries are present in the oral cavity, the use of crowns of any kind should be delayed until the conditions responsible for the tooth destruction can be controlled.
Extracoronial Restorations

If insufficient coronal tooth structure exists to retain the restoration within the crown of the tooth, an extracoronial restoration, or crown is needed. It may also be used where there are extensive areas of defective axial tooth structure, or if there is need to modify the contours of a tooth for removable partial dentures, or to refine occlusion, or to improve esthetics. Nowadays more often we use full veneer crowns, from those- metal-ceramic and all-ceramic crowns, and, sometimes, ceramic veneers.

Partial Veneer Crown
This is a crown that leaves one or more axial surfaces unveneered. It can be used to restore a tooth with one or more intact axial surfaces with half or more of the coronal tooth structure remaining. It will provide moderate retention, can be used as a retainer for short-span bridges.

Full Metal Crown
The full metal crown, or full veneer crown, can be used to restore teeth with multiple defective axial surfaces. It will provide maximum retention, but cannot be used in every situation because of esthetic considerations. The candidates for full veneer crowns are usually the second molars, rarely- the first molars.

Metal-Ceramic Crown
This crown can also be used to restore teeth with multiple defective axial surfaces. It will provide a very good retention, a little-bit less then a full veneer crown for the same tooth, but it has a good cosmetic result and can be done almost in every situation.

All-Ceramic Crown
When full coverage and maximum esthetics must be combined, this crown is the choice. The disadvantages of the all-ceramic crowns are the less resistance to fracture in comparison with metal-ceramic crowns and the removal of large quantities of tooth structure. To avoid the latter, ceramic veneers were offered to gain the same esthetic results without removing large quantities of sound tooth structure.
The preparation for any restoration has to be governed by following main five principles:

1. Preservation of tooth structure
2. Retention and resistance
3. Structural durability
4. Marginal integrity
5. Preservation of the periodontium

**Preservation of Tooth Structure**

The sound tooth structure has to be preserved as much as possible. It is obvious that not always we need a very cosmetic restoration, or a full crown instead of a partial one. Despite we have to sacrifice to the bur enough tooth structure to create adequate space for structural durability and esthetics of the crown, the preparation has not to be excessive. The unnecessary overtapered tooth preparation can result in sacrifice of retention and resistance. Also hypersensitivity, pulpal inflammation and necrosis can occur after a short period of time.

**Retention and Resistance**

For a restoration to survive in the oral cavity, it must stay cemented on the tooth, despite the dislodging occlusal forces. Every restoration undergoes the influence of tensile, shear and compressive forces (Fig.2-1).

![Fig. 2-1](#)  
**Fig. 2-1** Every restoration undergoes the influence of tensile (A), shear (B and C) and compressive (C and D) forces

All cements exhibit their greatest strength under compression and less- under tension. The value for shear strength lies between them. Thus, the adhesion of the cement solely is not enough to serve for its long- term fixation. For this, the geometric form of the preparation must place the cement as much as possible in compression and shear to provide necessary retention and resistance.
Retention

Retention prevents the removal of the restoration along the path of insertion or long axis of the tooth preparation.

The following factors greatly influence the retention of the restoration: degree of taper, total surface area of the cement film, area of cement under shear, roughness of the tooth surface.

Retention and taper

The retention decreases as taper increases (Fig. 2-2).

![Fig. 2-2 The retention decreases as taper increases](image)

It was verified experimentally, that the maximum retention will be with parallel walls of the preparation. However, in order to avoid undercuts and to allow complete seating of the restoration during cementation, the walls must have some taper. One which lies within the range of 2 to 6 degrees has been considered to be optimal (Fig. 2-3).

![Fig. 2-3 Optimal taper with an inclination of 3 degrees on each side](image)

However, studies of actual crown preparations, made in different laboratories, have found that the tapers of different teeth ranged from 13 to 29 degrees, with an average taper of 20 degrees.
Finally, a taper of total 16 degree convergence has been proposed to be clinically achievable, while affording adequate retention.

**Surface area of the cement film**

The greater the surface area of the cement film, the greater is the retention of the restoration. The surface area is influenced by the size of the tooth (Fig. 2-4), the extent of coverage by the restoration, and features such as grooves and boxes that are placed in the preparation.

Fig. 2-4. The greater the surface area of the cement film, the greater the retention. A restoration on a longer or a wider preparation have better retention, if all other factors remain constant.

**Area under shear**

For a restoration to stay cemented on a tooth it is very important that enough surface area of the cement film will experience shearing rather than tensile stress. For this, the preparation must have at least two opposing walls, nearly parallel to each other. The opposing surfaces may be internal (Fig. 2-5) and external, such as the axial walls of a full veneer crown preparation (Fig.2-6). So the retention can be internal, external, or a combination of the two types.

Fig. 2-5 Internal retention  Fig. 2-6 External retention
To obtain the greatest area of cement under shear, the restoration must have only one path of insertion. A severely overtapered preparation has many directions, in which the tensile force can remove the restoration (Fig. 2-7, A).
If features are added to such a preparation, the retention will greatly enhance not only because they increase the surface area of the cement film, but because most of the added surface area will be subjected to shear forces (Fig. 2-7, B).

Fig. 2-7 The enhancement of the retention by restriction of the possible paths of insertion

A full veneer crown can have excellent retention without adding additional features, because the mesial, distal, lingual and facial walls limit the possible paths of insertion to a narrow range, if the preparation is not overtapered (Fig. 2-8 A). But if the facial surface is left unveneered, (Fig. 2-8 B) it is very important to create additional features, such as grooves, boxes, or pinholes, to have a unique path of insertion, and, thus, to create a sufficient retention for the restoration (Fig. 2-9 ).

Fig. 2-8 The partial veneer preparation has very little retention without additional features

Fig. 2-9 The substitution of grooves (A), boxes (B) and pinholes (C) enhances the retention
Surface roughness

The adhesion of dental cements depends on the roughness of prepared tooth surface, because the cement will project into microscopic irregularities of the surface. This means, that the tooth has not to be highly polished. But we also have to remember, that the roughness can lead to problems with the impression, because the impression material can also penetrate into the overmentioned irregularities and this can lead to problems during impression withdrawal.

Resistance

Resistance prevents the dislodgment of the restoration by forces directed in an apical, oblique, or horizontal direction.

If a restoration is prone to move to any direction, the resistance is better if in this direction there is a wall, perpendicular to the direction of forces. In this situation the cement film is compressed, and we remember, that all cements exhibit their greatest strength on compression.

Leverage and Resistance

The strongest forces encountered in function are apically directed and they can produce tension and shear in the cement film only through leverage. Leverage, probably the predominant factor in the dislodgment of cemented restorations, occurs when the line of action of a force passes outside the supporting tooth structure.

If the force passes within the margin of a crown, there is no tipping of the restoration (Fig. 2-10,A). In this situation the force tends to seat the crown further. If the occlusal table of the restoration is wide, even a vertical force can pass outside the supported margin and produce destructive torque (Fig. 2-10,B). This can also occur in crowns on tipped teeth and retainers for cantilever bridges.

![Fig. 2-10 The influence of vertical forces acting in the margin of the restoration (A) and out of it (B)](image)

A force applied to a cemented crown at an oblique angle can also produce a line of action which will pass outside the supporting tooth structure (Fig. 2-11).
In the latter two situations rotational forces begin to act on the restoration, and the point on the margin that lies closest to the line of action is the fulcrum point, or the center of rotation (Fig. 2-11). The magnitude of the torque produced is equal to the applied force multiplied by its lever arm, which is the closest distance between the line of action and the fulcrum.

If we imagine an arc of rotation, which crosses the cement film on the opposite to the fulcrum point wall of the preparation, this cross-point will be called tangent point (Fig. 2-11). At all points apical to the tangent point stresses will have a component of tension. At P1 the cement film will be subjected only to shear forces and all points occlusal to P1 will be subjected to shear and compression. The compression component becomes greater the farther a point lies above the tangent point. The area, which is subjected to shear and compression forces, is called resisting area (Fig. 2-12).

**Preparation length and Resistance**

The length of a preparation greatly influences the resistance of the restoration. The longer the preparation, the bigger is the resistance of the restoration (Fig. 2-13).
If two crowns of unequal length are subjected to identical forces, the longer crown is more likely to fail because the force on it acts through a longer lever arm (Fig. 2-14).

Fig. 2-14. A short restoration on a short preparation is less likely to fail than a long restoration on the same preparation.

If we need to place a long crown on a short preparation, additional features have to be created to enhance the resistance of the preparation.

**Resistance and tooth width**

Although a wide preparation has greater retention because of bigger surface of the cement film, its resistance will be less, because it will have a longer radius of rotation resulting in a higher tangent line and a smaller resisting area (Fig. 2-15).

Fig. 2-15 The resisting area decreases, as the diameter of the preparation increases.

If additional features are added, such as grooves or boxes, a shorter radius of rotation creates large enough areas, substituted to shear forces, on groove walls (Fig. 2-16).

Fig. 2-16 The resistance of a short, wide preparation can be enhanced by addition of vertical grooves.
The more tapered is the preparation, the less is its resistance. The resisting area of a cylindrical preparation would include half of its axial surface (Fig. 2-17, A). As the degree of taper increases, the tangent line approaches the occlusal surface, and the resisting area decreases (Fig. 2-17, B).

The permissible taper of a preparation is directly proportional to the height/width ratio (Fig. 2-18).

The maximum allowable preparation tapers for various preparation height and width combinations are shown in Table I.

<table>
<thead>
<tr>
<th>Arch</th>
<th>M/D</th>
<th>F/L</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maxillary</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anterior tooth*</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Premolar*</td>
<td>14</td>
<td>14</td>
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</tr>
<tr>
<td>Premolar*</td>
<td>16</td>
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<td>14</td>
</tr>
<tr>
<td>Molar*</td>
<td>24</td>
<td>20</td>
<td>22</td>
</tr>
</tbody>
</table>

*Convergence angle.
M/D = mesiodistal; F/L = faciolingual
Rotation around a vertical axis

Although the restorations mostly deal with vertical or oblique forces, when rotation around a horizontal axis occurs, rotation about a vertical axis is also possible under influence of horizontal forces (Fig. 2-19).

![Fig. 2-19. The action of rotational forces on the restoration.](image)

A three-quarter crown, as well as a full crown on a cylindrical preparation without grooves has little resistance to rotational displacement (Fig. 2-20, A).

![Fig. 2-20. The rotational forces can be blocked by addition of grooves (A) or wings (B).](image)

The addition of grooves on a three-quarter crown, or creating wings places a resisting surface at right angles to the arc of rotation, effectively blocking it (Fig. 2-20 A, B).

Path of insertion

The path of insertion is an imagined line along which the restoration is placed or removed from the preparation. The path of insertion always has to be determined before beginning the preparation. It must be considered in two directions: faciolingually and mesiodistally. Often the path of insertion is parallel with the long axis of the tooth, if the tooth is normally positioned in the dentition. If the tooth is tilted mesially or distally, the path of insertion must not be parallel with the long axis of the tooth, because it will cause an undesirable destruction of the adjacent tooth on one side (Fig. 9-18).
Fig. 2-21. The path of insertion for a tipped tooth has to be perpendicular to the occlusal plane.

Fig. 2-22. The path of insertion for a full veneer crown on a posterior tooth in normal alignment parallels the long axis of the tooth (A). The path of insertion of a tipped tooth (B) has to be perpendicular to the occlusal plane (D), otherwise the adjacent tooth has to be damaged.

If the tooth is tilted facially or lingually and has to be relined, the path of insertion is determined by imagining the subsequent position of the restoration in the dentition and the long axis of the restoration. Even if the tooth is normally positioned in the dental arch, the path of insertion is not always parallel with the long axis of the tooth. For partial veneer crowns on frontal teeth, it should lead to unnecessary display of metal on the incisal edge of the tooth (Fig 2-23, A). To avoid this, the path of insertion must be determined with lingual inclination (Fig 2-23, B).
After the preparation is finished, it has to be correctly visualized to insure that no undercuts have been created. For the anterior teeth it can be checked out with one eye from a distance of approximately 30 cm. At this time we have to see the finish lines of the preparation outside the occlusal surface or the incisal edge (Fig 2-24).

Fig. 2-24. If both eyes are open, undercuts may remain undetected.

Fig. 2-25. The visualization of a preparation has to be done with one eye (A), because the binocular vision can ignore undercuts up to 8 degrees.
For the posterior teeth, where direct vision is rarely possible, a mouth mirror is used (Fig 2-26).

Fig. 2-26. Where direct vision is impossible, a mirror is used to evaluate the preparation.

To evaluate the parallelism of bridge abutments, the mouth mirror has to be placed over the first abutment, and then, without changing the angulation, moved distally (Fig. 2-27).

Fig. 2-27. For the visualization of bridge abutments, the mirror is placed over the mesial abutment and then moved bodily distally.
Part III

Structural Durability

As we know already, the preparation must not be overtapered to have longevity regarding to its retention and resistance. But we have to know also, that the restoration must contain a sufficient bulk of material that is adequate to withstand the occlusal forces. This bulk must be created in the space made by the tooth preparation. Only in this way the occlusal harmony and the adequate durability of the restoration will not cause periodontal problems around the restoration.

Occlusal Reduction

One of the most important factors to provide an adequate strength of the restoration is the occlusal clearance (Fig. 3-1).

For gold alloys, it should be 1.5 mm on the functional cusps and 1.0 mm on the nonfunctional cusps and in the grooves. For non-precious metal alloys it should be 1.0 mm on the functional cusps and about 0.6 mm on the nonfunctional cusps and in the grooves. Metal-ceramic crowns require 1.5 to 2.0 mm on functional cusps and 1.0 to 1.5 mm on nonfunctional ones. All-ceramic crowns will require 2.0 mm of clearance.

If the tooth is normally positioned in the dentition, we have to cut the over mentioned thicknesses from the tooth. But if the tooth is tilted on one side, we have already some space for the restoration material (Fig 3-2).

Fig. 3-1. The strength of the restoration depends much on the occlusal clearance.

Fig. 3-2. The introcclusal space over the mesial cusps of a tipped tooth may be sufficient for a crown preparation without any reduction.
So we will need less tooth structure to be cut from that side. The most often made mistakes are the flattening of the molar teeth without creating enough space in the groove area (Fig.3-3), and over reduction of the cusps, which leads to inadequate retention and resistance.

![Fig.3-3. Correct (A) and incorrect (B, C) reduction of the occlusal plane.](image)

**Functional Cusp Bevel**

If an inadequate functional cusp bevel is created, perforation of the casting (Fig. 3-4,A), or over contouring with leading poor occlusion (Fig. 3-4,B), or wear and perforation in the mouth can occur.

![Fig 3-4. Incorrect preparation of the functional cusp bevel](image)

**Axial Reduction**

Adequate axial reduction also plays an important role in providing sufficient strength to the restoration without over contouring it. If the axial reduction is insufficient, either the walls of the restoration are thin and can be damaged during clinical or laboratory procedures (B) or the restoration are over contoured (C), which will lead to subsequent periodontal destruction.

![Fig. 3-5. Correct preparation (A). Incorrect preparation can lead either to thin margins (B), which can be distorted during clinical and laboratory stages, or to over contouring (C) with subsequent periodontal inflammation and esthetic problems.](image)
Part IV

Marginal Integrity

The longevity of the restoration in the biological environment of the oral cavity depends a lot on the adaptation of the margins to the finish lines of the preparation. The quality of this adaptation is dependent on the professional skills of the dentist, lab procedures (professional skills of the technician and the laboratory itself), materials used by the dentist and the technician, and the type of the finish line of the preparation.

Four main types of finish line configurations are used nowadays in different clinical situations: chamfer, shoulder, beveled shoulder and knife-edge. These finish line configurations are different in their marginal adaptation because of the shrinkage in the coronal direction, which takes place during the laboratory procedures.

If we compare two restorations - one for a tooth with nearly parallel axial walls and knife-edge finish line and the other - for a tooth with some taper and shoulder finish line, after the same shrinkage in the lab for the both castings theoretically the first restoration again will have ideal marginal adaptation, no distance between the tooth and the restoration, but the second one will be on some distance from the tooth, especially over the shoulder finish line (Fig. 4-1 A, B). To avoid this, finish lines with some angle, i.e. chamfer, beveled shoulder, etc. were offered to minimize the distance between the edge of the restoration and the tooth (Fig. 4-1 C).

Fig. 4-1. A bevel allows closer approximation of a crown margin to the finish line. Although the distance D remains constant, the shortest distance between the margin and the tooth structure, d, in the presence of a bevel, is much smaller.

The more acute is the angle of the restoration, the shorter is the distance between the tooth and the edge of the restoration (fig.4-2).
Fig. 4-2. The smaller the angle between the prepared tooth surface at the finish line and the path of insertion, the less is the marginal opening.

However, there is another problem. If the edges of the restoration are too thin, they can be distorted during clinical and laboratory procedures. This problem is very often in knife-edge preparations, if we try not to overcontoure the restoration. For this, angles ranged from 30 to 45 degrees are offered. Another problem for long preparations or the ones with parallel axial walls can be the film thickness of the cement, which will prevent the complete seating of the casting. To avoid this, one should follow the recommendations for the tapers of different preparations, the mixing instructions of cements of different brands, and, if needed, a cement evacuation groove can be made after taking the impression.

**Finish Line Configurations**

The chamfer finish line (Fig. 4-3) is the preferred one for veneer metal restorations. It is broadly used also lingually for metal-ceramic restorations.

Fig. 4-3. Chamfer finish line

This finish line has been shown experimentally to exhibit the least stress, so that the cement, underlying it, will have less likelihood of failure. It can be cut with a round-end tapered diamond or a torpedo bur with rounded edges. A heavy chamfer, or a wide chamfer (Fig. 4-4), can serve also for a ceramic crown, but it is not as good as the shoulder.
The shoulder is the finish line of choice for the all-ceramic crowns (Fig. 4-5).

It is used also facially for metal-ceramic crowns for anterior teeth. The wide edge provides resistance to occlusal forces and minimizes the stresses that might lead to the porcelain fracture. Also it provides enough space for esthetics. However, although this is more esthetic finish line, it is also the most destructive one. If a strict 90 degree angle is created, this concentrates stress in the tooth and can lead to coronal fracture. For this, a small- radius rounded internal angle is instrumented by an end- cutting parallel- sided finish bur with rounded edges (Fig. 4-6).

The beveled shoulder (Fig. 4-7) is used as a facial finish line for metal-ceramic restorations where gingival esthetics is not critical.
Fig. 4-7. A beveled shoulder finish line

It is also used as the gingival finish line on the boxes of inlays and onlays. As it was mentioned above, the bevel makes better the marginal adaptation, but the acute angle makes the presence of ceramics in this area impossible, because the thin edges of the ceramics are very prone to fracture. For this, the beveled shoulder cannot be made in esthetic regions.

The easiest finish line preparation is the knife-edge (Fig. 4-8).

Fig. 4-8. Knife edge preparation

Unfortunately, its use can create a number of problems. Unless it is carefully cut, the finish line may fade out and the technician sometimes cannot determine it especially if periodontitis exists. The second problem is that the thin margin of the restoration is difficult to wax and cast accurately. To avoid the distortion of the margins during clinical and laboratory procedures, the third problem, the overcontouring is created. This can lead to plaque accumulation and subsequent gingivitis and periodontitis. Despite these disadvantages, the knife-edge can be used on very short teeth with small diameter, tilted teeth, on teeth with very convex axial surfaces, in furcation areas.
Part V

Preservation of the Periodontium

Before beginning the tooth preparation, we have to decide what kind of finish lines we will use and where they will be placed. The restoration will survive at maximum if the margins are as smooth as possible and are fully exposed to a cleansing action. Whenever possible, the finish line should be placed in an area where the margins of the restoration can be evaluated by the dentist and kept clean by the patient. Finish lines should be placed supragingivally when it is possible to do so. In the past, the traditional concept has been to place margins as far subgingivally as possible, based on the mistaken concept that the subgingival sulcus is caries-free. The practice of routinely placing margins subgingivally is no longer acceptable. Although the materials of the restoration, i.e. the metal or the ceramics don’t irritate the gingiva and generally don’t create an inflammatory response, there is a correlation between the depth of the restoration in the gingival sulcus and the potential risk for periodontitis. This problem overcomes because of the difficulties of the subgingival preparation, gingival retraction, impression techniques, subsequent clinical adaptation, cementation, and professional and individual health care.

Nonetheless, there will be many situations in which subgingival margins are unavoidable. These are the esthetic considerations in the front region, subgingival caries, the extensions of previous restorations, subgingival fracture of the tooth, need to increase the retention and resistance of the restoration.

All the way, despite the preparation design we have chosen, the preparation itself has to be as much atraumatic as possible for the periodontium.

Sometimes there can be situations, when the margin of the restoration has to be placed well subgingivally, but there isn’t enough space for the connective and epithelial attachments, i.e. for biological width. The biological width is the space between the edges of the restoration and the alveolar crest. It ranges from 2.5 to 3 mm from different points of view. If this distance is smaller, gingival and periodontal inflammation, loss of alveolar crest height and formation of a periodontal pocket often result. To avoid this, the biological width can be restored by surgically moving the alveolar crest 3.0 mm apically to the proposed finish line. Another choice can be the orthodontic extrusion of the tooth to open the root caries area or the subgingival fracture. If the proposed periodontal surgery is too traumatic for the neighboring tooth or the bone support for the orthodontically extruded tooth is too weak, the tooth can be extracted and the defect can be closed with any other solution.
Part VI
Instrumentation

Tooth preparations for cast restorations have been greatly changed in the recent decades. Among these changes were the development of diamond and carbide burs instead of large diameter diamond stones, wheels and disks. Next, the increase of handpiece speed from less than 10,000 rpm of belt driven handpieces to more than 100,000 rpm of the air turbine handpieces made possible efficient cutting with smaller instruments, which in turn made more sophisticated the preparation designs. To avoid overheating which is a critical problem in high-speed instrumentation, a double water-air cooling is necessary. Cutting dry at high speeds will produce nearly three times as much dentinal burning as cutting with a water spray, which can result in pulpal inflammation or necrosis. Even in nonvital teeth overheating should be avoided, since it can result in microfractures, failure of marginal integrity of the restoration and caries.

The use of air alone as a coolant has also another disadvantages: prolonged dehydration of freshly cut dentin will cause odontoblastic displacement and pulp damage. A low quantity of water, poorly directed, can also lead to some overheating. Beside this, a good water flow is effective for keeping the cutting edges of high-speed rotary instruments washed clean of debris and, actually, the spray enhances the visibility in the oral cavity by flushing away blood and debris.

Among all rotary instruments, used for tooth preparations, the most common used are the diamond stones and burs (Fig. 6-1 A, B). Diamond stones remove tooth structure by abrading, or wearing away the surface. Burs are miniature milling cutters with blades that shear tooth structure from the tooth surface, cutting primarily on the sides of the instrument. Less frequent twist drills can be used (Fig. 6-1, C).

Fig. 6-1. Diamond stone (A), carbide bur (B), twist drill (C).
**Diamond Stones.**

Diamond stones are available in different sizes, shapes and grits. The cutting effectiveness depends from the sizes of diamond particles, which are fixed to steel instrument blanks whose heads have been machined to the desired shapes. This can also be called coarseness of the diamond stones. The cutting effectiveness of diamond stones for enamel is much more, than that of carbide burs. The sizes of diamond stones can be suited to the taste of every operator but they also differ from case, depending on the tooth size. There are a great number of different shapes of diamond stones, which varies a little from a manufacturer to a manufacturer. But there are a few diamond stones which should be included in a basic set of instruments: the round-end tapered, flat-end tapered, long-needle, short needle, small round-edge wheel, torpedo and flame diamond (Fig. 6-2 and 6-3). The last two diamonds are frequently paired with carbide finishing burs of matching shapes (Fig. 6-3)
Tungsten carbide burs

Carbide burs are available with 6, 8, 12, 20 and even 40 blades (Fig. 6-4).

Fig. 6-4. Carbide burs with different cutting effectiveness.

First three ones are very effective to cut dentine and metal. The others are best used to finish the preparation features and smooth the surfaces of enamel or dentin. In some burs, the blades are interrupted by cuts across the edge. Burs made in this configuration are described as dentate or cross-cut burs. Dentate burs have been shown to be somewhat more effective than nondentate ones. From a great number of carbide burs tapered fissure burs, end-cutting bur and round burs have to be included in the standard armamentarium (Fig. 6-5).

Fig. 6-5. Tapered fissure burs (A, B, C), end-cutting bur (D), round burs (E, F) of different sizes.

The preparation of any design, anyway, has not to be done with a great number of instruments, because considerable time can be lost in trying many similar instruments, when what is really needed is mastering the skills to use the instrument which is already in the handpiece.
Part VII

Preparations for Full Veneer Crowns

There are numerous situations, when full veneer crowns have to be used. A number of studies have shown that full veneer crowns exhibit much more retention and resistance. The selection of a full veneer crown becomes mandatory when the tooth is small or when the occlusal forces are strong, for example if the tooth serves as an abutment for a long-span fixed or removable partial denture. The full veneer crowns also have to be used, if the partial veneer ones have been considered to a lack of esthetics or of proper restoration the tooth.

Nowadays, beside the full metal crowns, metal-ceramic and all-ceramic crowns are very often used. All the way, the full veneer crowns are overused now and it would be better to choose less destructive techniques whenever possible.

Full Metal Crown Preparation

When all of the axial surfaces of a posterior tooth have been attacked by decalcification or caries, or when those surfaces have been previously restored, the tooth is a candidate for a full metal crown. It can also be used, if we need to change the shape of the tooth for a removable partial denture.

The preparation for a full veneer crown begins with occlusal reduction. For gold alloy restorations, we need about 1.5 mm of clearance on functional cusps and about 1.0 mm on nonfunctional ones. For simple alloy crowns, we need correlatively 1.0 mm and 0.6 mm.

Depth orientation grooves can be placed to easily assess if the reduction is sufficient on every stage of the preparation (Fig. 7-1).

Fig. 7-1. The round-end tapered diamond is used to make depth orientation grooves on the triangular ridges and in the primary developmental grooves.
Fig. 7-2. The depth-orientation grooves should be 1.5 mm deep on the functional cusps and 1.0 deep on the nonfunctional cusps for precious metal alloys.

If reduction begins without orientation marks, time will be wasted in repeated checks for adequate clearance. A round-end tapered diamond is used to place the grooves on the functional cusp and on the rest of the occlusal surface. If there is already some clearance with the opposing tooth because of malpositioning or fracture of the tooth being prepared, the reduction has to be made less and only after estimation of the existing clearance. The tooth structure remaining between the orientation grooves is removed, keeping the occlusal surface in the configuration of the geometric inclines of any posterior tooth (Fig. 7-3).

Fig. 7-3. Planar occlusal reduction: round-end tapered diamond and no. 171 bur.

The functional cusp bevel, placed on the buccal inclines of mandibular buccal cusps and the lingual inclines of maxillary lingual cusps, is an integral part of the occlusal reduction. Failure to place this bevel can produce a thin casting, resulting in perforation, or an overcontouring, resulting either in poor occlusion, or reduction of the opposing tooth. Occlusal clearance can be checked by giving the patient a 2.0 mm thick strip of red utility wax to bite. If somewhere the reduction is insufficient, the wax will be detectable as a transparent spot on the light. Additional tooth structure then should be removed from indicated areas and rechecked.

The buccal and lingual walls are reduced with a torpedo diamond, simultaneously forming a chamfer finish line (Fig. 7-4).

Fig. 7-4. Buccal and lingual axial reduction: torpedo diamond.
The interproximal surfaces are initially cut with a short needle diamond (Fig. 7-5). This can be made either in occlusogingival, or in buccolingual “sawing” motion, being careful not to damage the adjacent tooth.

![Image](image-url)

Fig. 7-5. Complete axial reduction: short needle diamond and torpedo diamond.

![Image](image-url)

Fig. 7-6. Contact opening with a short needle diamond.

Once sufficient maneuvering space has been obtained, the torpedo diamond is used to plane the walls and simultaneously form a chamfer finish line, connecting the vestibular and lingual surfaces (Fig. 7-7) and trying to avoid forming undesirable sharp edges (Fig. 7-8).

![Image](image-url)

Fig. 7-7. Axial wall and chamfer finishing: Torpedo bur.
Fig. 7-8. A common error in connecting the vestibular and oral preparation surfaces to the contact surface preparations is the creating of V-shape finish line.

After finishing of the occlusal plane and functional cusp bevel a retentive groove is made with a no. 171 L bur (Fig. 7-9). All of the axial surfaces and the chamfer finish line are smoothed with a torpedo carbide finishing bur. Special care should be taken in rounding the corners from the buccal or lingual surfaces to the proximal surfaces to insure that the finish line will be smooth and continuous. The final step in the full veneer preparation is the placement of a seating groove (Fig. 7-9) with a no. 171 L bur. This usually will be on the buccal surfaces of mandibular teeth or lingual surfaces of maxillary teeth. The seating groove will prevent any rotational movements during cementation, creating only one path of insertion, and will help guiding the casting to place.

Fig. 7-9. Creating of the seating groove with the no 171 bur.

The features of a preparation for a full veneer metal crown and the function served by each are shown on (Fig. 7-10).
Fig. 7-10. Features of a mandibular full metal crown and the function served by each.
Anterior Three-quarter Crowns

Recently the anterior three-quarter crowns are used more and more rarely. The cause of this can be not only the frequent unnecessary display of gold on improperly made crowns, but also the obvious difficulty of tooth preparation. There are also numerous situations, when the three-quarter crowns are undesirable: when caries or previous restorations exist on facial or incisal edges of the tooth, if a tooth is unsightly discolored and if the clinical crowns are short and narrow. The best candidates for anterior three-quarter crowns are the thick, square anterior teeth with an adequate faciolingual bulk of tooth structure. These crowns are best used for short-span bridges with abutments that are relatively restoration- and caries-free. All the way, according to the small resisting area, comparing with the full veneer crowns, additional structures, such as pins, grooves and boxes must be added for adequate retention and resistance of the restoration. The direction of these additional structures has to be chosen correctly and be parallel with the path of insertion. The correct direction of the latter is imperative to achieve an esthetic restoration. The steps for a preparation of an anterior three-quarter crowns will be described on a maxillary canine. A silicone index can be made before the preparation is begun.

Fig. 7-11. A silicone index can be taken to help an inexperienced operator.

Then the lingual reduction begins. For this, depth-orientation cuts are made on the lingual surface with round diamonds approximately 0.7 mm in depth (Fig 7-12).

Fig. 7-12. Lingual reduction: small wheel diamond.
Afterwards the lingual reduction is completed with a small round-edged diamond wheel, creating a concave surface and avoiding cutting excessive tooth structure from cingulum area (Fig 7-13).

![Fig. 7-13. Incisal reduction: small wheel diamond.](image)

Then incisal edge is prepared. To do that depth-orientation cuts are made on the incisal edge (Fig 7-14), not overreducing it, because it will inevitably compromise the esthetics.

![Fig. 7-14. Making depth orientation cuts on the incisal edge with a round-end tapered diamond.](image)

Then the incisal reduction is made with a small round-edged wheel diamond (Fig 7-15).

![Fig. 7-15. The incisal reduction has to be parallel with the unprepared incisal edge.](image)
On a canine it results in repeating the anatomically existing mesial and distal inclines of the incisal edge. On an incisor the incisal reduction will be a straight line. Then lingual axial reduction is done with a torpedo diamond (Fig 7-16), creating a chamfer finish line.

![Fig. 7-16. Lingual axial reduction.](image)

The lingual axial wall, as possible, has to be parallel with the incisal two-thirds of the vestibular surface, dictating to have a path of insertion with lingual incline. The proximal axial reduction is done first with a long needle, then with a torpedo diamond (Fig 7-17).

![Fig. 7-17 Proximal axial reduction: long needle and torpedo diamond.](image)

At this time problems, like underextension of the faciogingival angle (Fig 7-18) or overextension facially can occur.

![Fig. 7-18. Underextension of the faciogingival angle has not to be created while making the proximal axial reduction.](image)
Normally the extension in a facial direction should just slightly break the contacts with the adjacent teeth (Fig 7-19).

Fig. 7-19. The preparation must be instrumented from the lingual to facial direction to avoid overextension.

Now, when the overall reduction is almost made, the retentive grooves have to be made. Their direction has to be parallel with the path of insertion. The two grooves have to be also parallel to each other. After the grooves are finished and their directions are verified (Fig 7-20), proximal flares are made with flame diamond and flame bur (Fig 7-21).

Fig. 7-20. The proximal grooves have to be parallel to each other and to the path of insertion.

Fig. 7-21. Proximal flares: flame diamond and bur.
A sandpaper disk can also be used to finish the flare, retaining a flat surface, which is wider at the incisal portion of the tooth. At this moment it is imperative not to round the internal angles of the retentive groove, because it will compromise the retention and resistance of the restoration, and not to round the incisal edge, because it will lead to marginal leakage and will compromise the esthetics. After the flares are finished an incisal offset is made with a N171 bur (Fig. 7-22).

![Incisal offset: no 171L bur.](image1)

It has to be placed as close to the incisal edge as possible, without undermining the enamel. The incisal offset is made to provide an adequate bulk of metal near the narrow finishing bevel on the incisal edge. After the offset is made the sharp angles between the incisal reduction and the vertical wall of the offset and the two flares are rounded with a nondentate tapered fissure bur (Fig 7-23).

![Rounding the sharp angles between the vertical wall of the offset and the incisal reduction with a no 171 bur.](image2)

The last stage is the incisal bevel, made with a flame diamond and a N 170 bur (Fig 7-24).

![Incisal bevel: flame diamond and no 170 bur.](image3)
Fig. 7-25. Creating finishing bevel about 0,5 mm wide by no 170 carbide bur, to produce the sharpest finish line.

The quality of the finished preparation can be verified with the silicone index, cut in different directions.(Fig. 7-26)

Fig. 7-26. The vertically cut midsagittal index shows the quantity of lingual reduction as the preparation was finished.

The features of an anterior three-quarter crown and the function served by each are shown in(Fig 7-27)

Fig. 7-27. The features of an anterior three-quarter crown and the function served by each.
Part VIII

Metal- Ceramic Crowns

The metal- ceramic restoration, also called porcelain- fused- to metal restoration, consists of a ceramic layer bonded to a thin cast metal coping that fits over the tooth preparation. Such a restoration combines the strength and accurate fit of a cast metal crown with the cosmetic effect of a ceramic crown. With a metal understructure, metal- ceramic restorations have greater strength and longevity, than restorations made of ceramic alone.

Since this restoration is made to achieve a good cosmetic result, there is need for deep reduction on the facial surface to provide enough space for a thin metal coping and a thick ceramic layer, and a shallower reduction on the lingual surface and the lingual aspects of the proximal surfaces, which are generally needless to be too esthetic. Because of this difference a wing can be formed on each proximal surface where the deep facial reduction ends and the shallower proximal reduction begins.

Generally, the thickness of the metal coping made from gold alloy has to be 0.4- 0.5 mm, and the one made from simple alloy- 0.2- 0.3 mm. The ceramic layer has to be at least 0.7- 1.0 mm in the gingival part and can be up to 2.0 mm at the incisal edge.

If sufficient space for the restoration is not created, the restoration will be poorly contoured, affecting both the cosmetic effect of the crown and the periodontal health, or (and) the shade and translucency of the restoration will not match to adjacent natural teeth.

Anterior Metal- Ceramic Crowns

Before the preparation begins, if the tooth is normally positioned in the dental arch, a silicone index can be taken, to objectively assess the quality of the finished preparation.

The index should cover the labial and lingual surfaces of the tooth to be prepared and at least one adjacent tooth from each side (Fig.8-1) after the index is removed.

The initial step in the preparation is again the placement of depth- orientation grooves. (Fig. 8-2). First they are made on the incisal edge, parallel to it, then the labial surface with a flat- end tapered diamond. (Fig. 8-3)

Fig. 8-1. A midsagittal index can be created by sectioning the silicone putty from gingivofacial to gingivolingual along the midline of the tooth to be prepared.
The labial grooves and subsequent reduction should be made in two directions: one parallel with the gingival half and another parallel with the incisal half of the labial surface (Fig. 8-3).

The incisal reduction has to be done parallel to the unprepared incisal edge with the flat-end tapered diamond (Fig. 8-4).

If the incisal reduction is insufficient, poor incisal translucency will appear in the finished restoration. The axial labial reduction is done in two directions, parallel to incisal and gingival portions of the tooth, coming 1.0 mm lingually from the proximal contacts (Fig. 8-5).
Fig. 8-5. Correct (A) and incorrect (B, C) preparations of the facial surface. The preparation of the gingival part results in creating a shoulder finish line. (Fig. 8-6)

Fig. 8-6. Facial reduction, gingival half: flat-end tapered diamond.

Several mistakes can be made on this stage. First, if the labial reduction of the incisal portion is insufficient, this will result in overcontouring or opacity of this part of the restoration (Fig. 8-5, B).

If the labial reduction is made in one plane and it is efficient, overtapering will result with insufficient retention and resistance and pulp damage can occur (Fig. 8-5, C).

If the axial labial reduction, resulting in a shoulder finish line, will not turn well interproximally, insufficient space will be left to create a natural appearance in gingival portions of proximal parts of the restoration.

The lingual surface is reduced with a small wheel diamond to obtain a minimum of 1.0 mm of clearance. (Fig. 8-7)

Fig. 8-7. Lingual reduction: small wheel diamond.
For this depth, orientation marks can be made first with a round diamond with a known diameter (Fig. 8-8).

![Fig. 8-8. Depth orientation marks with a round bur.](image)

The cingulum area has not to be overreduced not to compromise the retention. A long needle diamond is used then to prepare the contact points, then the preparation is accomplished with a torpedo diamond, simultaneously creating a chamfer finish line on the lingual and proximal walls (Fig. 8-9).

![Fig. 8-9. Lingual axial reduction and finishing.](image)

The lingual and proximal axial surfaces are smoothed with a torpedo bur, accentuating the chamfer on the lingual and proximal surfaces at the same time. The facial surface is finished with a flat-end finishing bur (Fig. 8-10).

![Fig. 8-10. Facial axial finishing: no171 bur](image)
The shoulder finish line is finished with no 957 bur, or can be hand-planed with a modified binangle chisel with rounded angles (Fig. 8-11).

![Fig. 8-11. Shoulder finishing](image)

After the preparation is finished, it can be checked-out with the silicone index (Fig. 8-12). On the midsagittal cut the difference between the vestibular and lingual preparations is evident.

![Fig. 8-12. The silicone index shows the quality of the overall finished preparation.](image)

The features of a preparation for an anterior metal-ceramic restoration and the function served by each are shown in (Fig. 8-13).

![Fig. 8-13. The features of a preparation for an anterior porcelain-fused-to-metal crown and the function served by each.](image)
Posterior Metal-Ceramic Crowns

Although the routine use of metal-ceramic crowns on posterior teeth is overtreatment because additional tooth structure has to be destroyed for combined thickness of metal and ceramics, nowadays more and more patients require esthetic restorations on posterior teeth, out of appearance zone, i.e. on maxillary second molars, mandibular molars and even wisdom teeth. The steps for a preparation of a posterior porcelain-fused-to-metal crown will be described on a maxillary premolar. The first step is the planar occlusal reduction, which is made with a round-end tapered diamond and N171 bur (Fig 8-14).

![Planar occlusal reduction](image)

For this, depth-orientation grooves are first created to have enough clearance of minimum 1.5-2mm (Fig 8-15).

![Making depth-orientation grooves](image)

The occlusal reduction is then accomplished by removing the sound tooth structure between the grooves. The reduction of the occlusal surface should be made reproducing the basic geometric shape of the occlusal surface. The next step is the reduction of the functional cusp bevel. Again depth-orientation grooves are first made. The tooth structure is removed between the grooves (Fig 8-16).

![Functional cusp bevel](image)
After the overall occlusal reduction is completed, the preparation of the facial surface begins. The depth-orientation grooves are made in two directions – in the occlusal and gingival portions of the facial surface with a flat-end tapered diamond (Fig 8-17).

Fig. 8-17. Depth-orientation grooves on the vestibular surface in two directions.

Then the facial reduction is accomplished by removing the tooth structure between the grooves with the same flat-end tapered diamond in two directions, simultaneously creating a shoulder finish line (Fig 8-18, 8-19).

Fig.8-18. Facial reduction, incisal half.

Fig.8-19. Facial reduction, gingival half.

The facial reduction and the created shoulder finish line have to extend well interproximally, to make enough space for natural looking in the mesiobuccal and distobuccal parts of the restoration.

Then the proximal contacts are carefully opened with a short-needle diamond (Fig 8-20) not to damage the neighboring teeth.
Fig. 8-20. Proximal axial reduction: short needle diamond.

The instrument can be used either in up-and-down motion on the facial or lingual aspect of the interproximal tooth structure, or it can be held horizontally and used on the occlusal portion with a faciolingual movement (Fig. 8-21).

Fig. 8-21. Faciolingual (A) or up-and-down (B) movements for proximal axial reduction.

After the lingual axial reduction is made with a torpedo diamond (Fig. 8-22).

Fig. 8-22. Lingual axial reduction.
At the same time the interproximal surfaces are also prepared with the same torpedo diamond, simultaneously creating a chamfer finish line (Fig 8-23).

Fig. 8-23. Axial finishing: torpedo bur and no 171 bur.

The difference between the thicknesses of the facial and lingual reductions creates “wings” on the proximal parts of the facial surface. The axial finishing is made with a torpedo finishing bur, simultaneously finishing the chamfer finish line with the same carbide finishing bur. The facial surface and the occlusal plane are finished with a N171 bur. At the same time all sharp edges of the preparation have to be rounded. The shoulder finish line can further be finished with an end-cutting bur (Fig 8-25).

Fig. 8-24. Shoulder finishing: no 957 bur.

Fig. 8-25. Shoulder finishing: no 957 bur.
End-cutting diamonds with rounded angles can also be used at this stage not to create undercuts, if the shoulder is wider than 90. The finishing of the shoulder finish line can be accomplished also with an enamel chisel, not accentuating the internal angle (Fig 8-26).

![Fig. 8-26. Shoulder finishing with an enamel chisel.](image)

After the shoulder finish line is meticulously finished, a bevel can be made with flame diamond and finishing bur (Fig 8-27).

![Fig. 8-27. Gingival bevel.](image)

As it was overmentioned, the bevel can lead to better marginal adaptation, than the shoulder, but it can create also esthetic problems, if it is not made well intragingivally or if the gingiva is thin and the metal colour is visible through mucosa. Also the preparation has to be very distinct and delicate, the impression has to be correct and the technician has to be a highly-qualified. Because of these difficulties a beveled shoulder is made in those areas or in those patients, for whom the esthetic needs are not so critical. If the esthetic considerations are of major importance, an all-ceramic margin over a shoulder finish line can be created on the same porcelain-fused-to-metal restorations.
The features of preparation for a porcelain-fused-to-metal-crown on a posterior tooth and the functions served by each are shown in (Fig 8-28).

Fig. 8-28. The features of preparation for a porcelain-fused-to-metal-crown on a posterior tooth and the function served by each.
Part IX

ALL-CERAMIC CROWNS

The use of all-ceramic crowns is highly recommended, if the patient requires a very cosmetic restoration in the esthetic zone. Nevertheless, the all-ceramic crowns are not indicated for teeth with an edge-to-edge occlusion because of high stress concentration in the incisal area, also they should not be used when the opposing teeth occlude on the cervical fifth of the lingual surface, because a “half-moon” fracture is very likely to occur in this area. Teeth with short clinical crowns also are poor candidates for all-ceramic crowns, because they will not have enough retention and resistance. Finally, the all-ceramic crowns are more prone to fractures, than the metal-ceramic ones, so the patients should be informed that the best candidates for all-ceramic restorations are the incisors.

The steps for all-ceramic crowns will be described on the upper central incisor. Before the preparation begins, a silicone index can be taken to verify the correctness of the preparation. To begin with, depth orientation grooves are placed on the incisal edge and vestibular surface in two directions, parallel to the incisal and gingival halves of the vestibular surface with a flat-end tapered diamond (Fig 9-1).

![Fig.9-1. Depth-orientation grooves.](image1)

The grooves are 1.2 to 1.4 mm deep on the labial and 2.0 mm deep on the incisal surfaces. Then the reduction is accomplished between the grooves with the same flat-end diamond. The reduction of the incisal edge has to be parallel with the unprepared incisal surface. (Fig.9-2)

![Fig.9-2. Depth-orientation grooves and incisal reduction.](image2)
Fig. 9-3. Labial reduction (incisal half): flat-end tapered diamond.

The labial surface has to be prepared in two planes to achieve adequate clearance for the restorative material without traumatizing the pulp. The labial preparation will form simultaneously a shoulder finish line, which has to be minimum 1.0 mm wide (Fig.9-4).

Fig. 9-4. Facial reduction: gingival half (flat-end tapered diamond).

The lingual reduction is then made with a small wheel diamond (Fig. 9-5).

Fig. 9-5. Lingual reduction: small wheel diamond.

For this depth orientation marks of 0.7-1.0 mm in depth can be created with a ball diamond with a known diameter. (Fig.9-6)

Fig. 9-6. Making depth-orientation marks with a ball diamond.
Afterwards the lingual axial wall and the proximal surfaces are prepared with the same flat-end tapered diamond, rounding the angles and obtaining a circular shoulder finish line (Fig. 9-7).

![Fig. 9-7. Axial reduction: flat-end tapered diamond.](image)

The axial finishing is then made with a N171 bur (Fig 9-8).

![Fig. 9-8. Axial finishing: no171 bur.](image)

All sharp edges and corners have to be rounded at that time (Fig 9-8), to avoid stress concentration and possible fracture of the all-ceramic crown.

![Fig. 9-8. Rounding all sharp angles with a tapered fissure bur.](image)
The shoulder finishing is done with a N957 bur. (Fig. 9-9)

Fig. 9-9. Shoulder finishing.

It can be accomplished also with a diamond with rounded angles not to create a sharp internal edge, because it will not be reproduced well by porcelain and this will lead to stress concentration. A 1.0 mm-wide enamel hatchet with rounded angle can also be used to plane the surface of the shoulder and to check its width. (Fig. 9-10)

Fig. 9-10. A rounded angled enamel hatchet can be used to plane the surface of the shoulder.

The features of a preparation for an all-ceramic crown and the function of each are shown in picture (Fig. 9-11)

Fig. 9-11. The features of preparation for an all-ceramic crown and the function served by each.
**Gingival retraction** permits completion of the preparation and cementation of the restorations and helps the operator to make a complete impression of the preparation. The techniques used for gingival retraction can be classified:

- Mechanical
- Chemico - mechanical
- Surgical

Mechanical methods include the use of copper band, retraction cord, rubber dam.

Chemico - mechanical methods include the use of gingival retraction cords.

Surgical methods include rotary curettage and electrosurgery.

Chemico - mechanical methods of gingival retraction is a method of combining a chemical with pressure packing, which leads to enlargement of the gingival sulcus as well as control of fluids seeping from the sulcus. We know that a gingival retraction cord soaked in a chemical (which promotes gingival contraction) will provide better gingival retraction compared to a plane retraction cord.

The following chemicals are generally local vasoconstrictors which produce transient gingival shrinkage.

- 8 per cent Racemic epinephrine
- Aluminium chloride
- Aluminium potassium sulphate
- Aluminium sulphate
- Ferric sulphate

Ideal requirements for chemicals used with gingival retraction cords.

- It should produce effective gingival displacement and haemostasis.
- It should not produce any irreversible damage to the gingival.
- It should not have any systemic side effects.

**Impression**

An impression for a cast restoration should meet the following requirements:

1. It should be an exact duplication of the prepared tooth, including all of the preparation and enough uncut tooth surface beyond the preparation to allow the dentist and technician to be certain of the location and configuration of the finishing line.
2. Other teeth and tissue adjacent to the prepared tooth must be accurately reproduced to permit proper articulation of the cast and contouring of the restoration.
3. It must be free of bubbles, especially in the area of the finish line and occlusal surfaces of the other teeth in the arch.

**Impression technique**

- Double mix
• Single mix
• Closed Bite Double Arch Method or triple tray technique.

**Double mix technique**

- A suitable stock tray is selected.
- Tray adhesive is applied uniformly into the tray.
- Putty impression material is mixed and made into a rope and loaded onto the tray.
- Making and removing the impression.
- The impression is additionally relieved by scraping the areas, which recovered the tooth preparation.
- The light body material is then syringed over the putty impression and also over the tooth preparation.
- The final impression will contain the accurate details recorded by the light body materials.

**Single mix technique**

In this procedure both the materials (light body and putty) are used simultaneously.

- The putty material is loaded into the stock tray.
- The light body material is syringed around the tooth preparation.
- A full mouth impression is made using the loaded stock tray.

**Closed Bite Double Arch Method or triple tray technique.**

- The syringe material is injected into the area to be recorded.
- The high viscosity material is mixed and placed in excess on both the arches.
- The tray is placed in between the arches.
- Patient is asked to inter-digitate (bite) slowly.
- As the patient opens his mouth, the tray will adhere to one arch.
- Bilateral pressure (right and left) should be applied to remove the tray as it helps to minimize distortion.

PROVISIONAL (TEMPORARY) CROWNS AND BRIDGES

The word “provisional” means established for the time being, until a permanent arrangement can be made. After tooth preparation, a temporary protective/ functional restoration is fabricated over the prepared teeth to be used until the fabrication of the final prosthesis. Temporary restorations are usually fabricated and provided on the same day of tooth preparation.

Ideal requirements for provisional restorations

Even though a definitive restoration can be placed as soon as two weeks after tooth preparation, the provisional restoration must satisfy important needs of the patient and dentist. The basic
requirements for provisional restorations can be broadly classified into biological, mechanical and aesthetic requirements.

Biological requirements

A temporary restoration should:

- Protect the pulp and the tooth structures. If the prepared tooth is left uncovered, increased sensitivity, caries and pulpitis can develop.
- Maintain the periodontal health. The temporary restoration might protect the periodontal tissues from traumatization by the food during mastication, without irritating the marginal periodontium.
- Have good occlusal compatibility (harmony). Tooth position should establish contact with adjacent and opposing teeth. Inadequate contacts will lead to supra-eruption and horizontal movement of the opposing and adjacent teeth respectively.

Mechanical requirements

They include function, displacement and removal for reuse.

Function

The temporary crowns and bridges should restore the lost function of the teeth, i.e. mastication, speech, etc.

Displacement

The displacement of temporary restoration can be prevented through proper tooth preparation and a provisional restoration with a closely adapted internal surfaces.

Removal for reuse

The provisional restoration should not be damaged during removal. The luting agent should be sufficiently weak to allow removal.

Material requirements

Usually provisional restorative materials are of fluid consistency during fabrication, which become rigid once the material is set. Hence, the setting/set material should have the following requirements.

- Convenient handling. Adequate working time, easy moldability, rapid setting time, etc.
- Biocompatibility: non-toxic, non-allergic, non-exothermic
- Dimensionally stable during setting
- Easy to contour and polish.
- Adequate strength and abrasion resistance.
- Good aesthetics. Translucency, colour, conturable, colour stable.
- Good patient acceptance: the material should be non-irritant to the oral tissues.
• It should be easy to repair or add more material.
• Chemical compatibility with provisional luting agents: It should not react adversely with luting agents used to fix the restoration.

Types of provisional restorations.

Provisional restorations can be classified on the following methods.

- Method of fabrication
- Type of material used
- Duration of use
- Technique for fabrication

Depending on the method of fabrication

- Custom made
- Preformed restorations

Depending on the type of material used

- Resin-restorations
- Metal restorations

Based on duration of use

- Short-term temporary: for use up to 2 weeks
- Long term temporary: for use from 2 weeks to a few months.

Depending on the technique of fabrication

- Provisional restorations fabricated using direct technique
- Provisional restorations fabricated using indirect technique

**Depending on the method of fabrication**

**Custom made provisional restorations.**

The restoration is fabricated individually to reproduce the original contours of the tooth. This can be done by direct or indirect technique in the oral cavity or in the laboratory.

**Advantages**

- A wide variety of materials can be used
- No limits in the shape of the restoration
- Helpful in evaluating the adequacy of tooth reduction.

**Disadvantages**
Thermal and chemical injury can arise during direct technique
For indirect technique additional lab procedure is acquired
Time consuming

Preformed provisional restorations

Preformed crowns are commercially available prefabricated crowns. These crowns are available in various sizes. The operator can choose the size and material that would best suit the patient and place it as a provisional restoration. Before cementation these crowns are slightly altered and modified to fit the tooth.

Advantages
- Less time consuming

Disadvantages
- Rarely satisfies the requirements of contour.
- It has to be customized with self-cure resin intraorally.
- Generally limited to single tooth restorations.

Commonly available preformed crowns include polycarbonate, cellulose acetate, aluminium and tin-silver.

Polycarbonate
- Has the most natural appearance
- Usually available in a single shade
- But can be altered by the shade of the luting agent
- Available for incisors, canine and premolar teeth.

Cellulose acetate
- It is available as shells into which auto-polymerizing resin can be filled and inserted over the prepared tooth. As the resin does not bond to the shell, it can be easily removed.
- It is a thin (0.2 to 0.3 mm), transparent material
- It is available in all tooth types (incisors, molars etc.)
- The shade of this temporary crown depends entirely on the auto-polymerizing resin. Shade matching can be done by adding colors to the resin.

Aluminum and tin-silver
- These materials are suitable for posterior teeth
- They have anatomically shaped occlusal and axial surfaces.
- Care must be taken during try-in verification to avoid fracture of their delicate margins
- As it is highly ductile, it allows easy contouring.
- The crown may require cervical enlargement during insertion. This can be done using special instruments like swapping or stretching blocks.

Nickel-chromium.
- These are used for children with extensively damaged primary teeth
• They cannot be altered with resin
• These crowns can be easily recontoured using pliers
• They should be cemented using high strength luting agents
• Very strong
• Indicated for long-term temporaries.

**Depending on the type of material used**

Resin based provisional restorations

• Cellulose acetate
• Polycarbonate
• Poly-methyl methacrylate (chemically activated resin)
• Microfilled composite
• Light cured resins

Metal provisional restorations

They are usually fabricated using

• Aluminium
• Nickel-chromium
• Tin-silver

**Depending on duration of use**

Short-term temporary restorations:

• These are used when the prosthesis is to be used for a maximum of two weeks.
• They are indicated after tooth preparation in fixed partial dentures
• They are either custom-made resins or available as preformed crowns
• Polycarbonates or aluminum crowns are the most commonly used short-term temporary constructions

Long term temporary restorations

• Long span posterior fixed partial dentures
• Prolonged treatment time
• If the patient is unable to avoid excessive forces on the prosthesis

**Depending on technique of fabrication**

Provisional restorations can be fabricated by direct or indirect technique.

The direct technique includes the adaptation of the performed crowns and the fabrication of the custom-made temporary crowns and bridges in the oral cavity with the help of different resin-based materials.
Fabricating a direct, composite provisional restoration

- First, an over-impression is made using silicone material.
- After making the over impression, tooth preparation is carried out
- The prepared tooth is coated with petrolatum. All undercuts are eliminated in the impression, especially in interdental spaces.
- The base and catalyst of the composite are mixed and loaded into the over-impression
- The over-impression is reseated in the patient's mouth
- The composite is allowed to polymerize intraorally for 10 minutes.
- The over-impression removed and the polymerized composite restoration should be carefully seated out.
- Voids in the restoration can be repaired by adding additional material.
- Finally, the restoration is finished, polished and cemented.

If a temporary bridge has to be fabricated, the impression is taken before removal of the old bridge. If the tooth is already damaged, abutment teeth are not covered with any restoration; some silicone material has to be removed after taking the impression to create adequate space for the temporary crown and bridge material.

Provisional restorations fabricated using indirect technique.

Here, the temporary crown or the bridge is entirely fabricated in the lab. The work can be done with a self-cured or heat-cured resin.

Fabrication of a temporary restoration using self-cured resin can be in the following way. An impression has to be taken with a silicone material before tooth preparation or removal of the old crown or bridgework. After the final tooth (teeth) preparation an impression of the prepared tooth (teeth) surface is recorded and a cast is poured. Then, the undercuts are eliminated in the impression, which is loaded with self-cured resin and set over the cast. After polymerization the impression is removed and the restoration is carefully seated out. Voids in the restoration can be repaired by adding additional material. Finally, the restoration is finished, polished and cemented.

Fabrication of a temporary restoration using heat-polymerized resin can be done in the following way.

An impression of the prepared tooth (teeth) surface is recorded and a cast is poured. An impression is taken also from the opposing jaw; bite registration has to be done. A wax pattern is fabricated on the cast, which is polymerized, finished and inserted. The most actual disadvantages of the abovementioned method are the time consuming, expensiveness of the temporary restorations, need for a lab and a technician. The advantages are fabrication of an aesthetic, non-toxic restoration with more color stability, than can have the restorations made by self-cured materials.
Limitations of provisional restorations

- Lack of inherent strength: Temporary restorations tend to fracture especially when placed over long-span ridges in patients with bruxism and in cases with reduced inter-occlusal clearance.
- Difficult to achieve good marginal adaptation
- Poor color stability of resin based temporary materials
- Poor wear properties
- Detectable odour: resins are porous; hence, they absorb oral fluids. This leads to its characteristic odour.
- Inadequate bonding characteristics: Very few temporary luting agents adhere well to the tooth structure.
- Poor tissue response often resulting in mild to moderate tissue irritation.
The causes of tooth partial destruction

- carious

- noncarious

**Non carious causes**

- Increased attrition
- Erosion
- Trauma (acute and chronic)
- Hypoplasia of enamel and dentin
- Scratches of enamel and dentin

The clinical picture of tooth partial destruction depends on sizes and localization of the defect.

Complaints

- can be absent or they can be:
- pains caused by physical and chemical factors
- inflammation of interdental papilla and food deposit in interdental space

Symptoms of partial absence of the tooth crown

- disorder of tooth anatomical form and as a result disorder of its function
- increased sensitivity to physical and chemical factors (if the tooth is vital)
- loss of tooth contact point and affection of marginal periodont (if the cavity is on the contact surface of the tooth)
- Injury of the mucous membrane of the oral cavity by acute borders of the defect
- esthetic and speech disorders

A crown is a cemented extracoronal restoration that covers, or veneers, the outer surface of clinical crown. It should reproduce the morphology and contours of the damaged coronal portions of a tooth while performing its function. If it covers the entire clinical crown, the restoration is a full or complete veneer crown.

The selection of the material and design of the restoration is based on several factors:

Destruction of tooth structure

Esthetics

Financial considerations

Retention

**Indication to crown use:**

1. Restoration of tooth structure damages of different origins, which we can’t restore by filling, inlay, onlay
2. When the destruction of the tooth crown structure is above 50%
3. crown would be the restoration of choice is when a patient desires to have his or her smile esthetically improved but when partial coverage (i.e. a veneer/laminate) is not an option for one or more of a number of reasons.
4. Endodontically treated teeth
5. Dental implant may then be fitted with a number of different prostheses such as crown.
6. Another situation in which a crown is the restoration of choice is when a tooth is intended as an abutment tooth for a removable partial denture.

Contraindication for crown use

1. Untreated pathological processes in periapical part of the root
2. Tooth mobility above 2-3 mm
3. When we have 3/4 and more alveolar bone atrophy near the root

Classification of the crown by material

1. Full metal crown (gold, base metal)
2. Acrylic resin /for temporary crown/
3. Metal ceramic crown
4. Metal acrylic crown
5. All ceramic

Full metal crown

The full metal crown can be used to restore teeth with multiple defective axial surfaces. It will provide maximum retention, but cannot be used in every situation because of esthetic considerations. The candidates for full metal crowns are usually the second molars, rarely the first molars. It can be used as retainer for short-span bridges.

Metal ceramic crown

In general, the metal-ceramic crown combines certain favorable properties of metal in its substructure and of ceramic in its veneer coating.

This crown can also be used to restore teeth with multiple defective axial surfaces. It will provide a very good retention, a little-bit less than a full metal crown for the same teeth, but it has a good cosmetic result and can be done almost in every situation.

All ceramic crown

When full coverage and maximum esthetics must be combined, all-ceramic crown is the choice. The disadvantages of the all-ceramic crowns are the less resistance to fracture in comparison with metal-ceramic crowns and the removal of large quantities of tooth structure.